Amendments to the Drawings:

The attached sheet of drawings includes changes to Figures 1-5 in which the legend "Prior Art" has been inserted in Figures 1 and 2. In addition, the reference numeral 61 (designating the block between 32 and 33) in Figure 3 has been changed to 31, and the reference numeral 61 (designating the bypass line) has been changed to 68 in Figure 5.

Attachment: Replacement Sheet

REMARKS

In response to item 1 on page 2 of the Office Action, the legend "Prior Art" has been inserted into Figures 1 and 2 in the attached replacement sheets. In addition, in Figure 3, the reference character 61 has been changed to 31, to conform to the numbering in the specification itself, while the reference numeral 61 (designating the bypass line) has been changed to 68 in Figure 5. Finally, in response to item 2 on page 2 of the office Action, the reference to "Fig. 6" at page 11 of the specification has been amended to refer to "Fig. 5". Accordingly, reconsideration and withdrawal of the objections to the drawings in items 1 through 4 are respectfully requested. Similarly, based on the above revisions, Applicants also respectfully request reconsideration and withdrawal of the objections to the specification as set forth in items 5 and 6 on page 4 of the Office Action. Applicants note in this regard that they have reviewed the specification, as requested, and have corrected additional potential informalities as well.

Claims 1-5 and 8 have been rejected under 35 U.S.C. §103(a) as unpatentable over Morse et al (U.S. Patent No. 6,530,237) in view of Klusmier (U.S. Patent No. 4,693736). In addition, Claim 6 has been rejected as unpatentable over Morse et al and Klusmier, and further in view of Kanai et al (U.S. Patent No. 6,321,544); and finally, Claim 7 has been rejected as unpatentable over Morse et al in view of Kanai et al. However, for the reasons

set forth hereinafter, Applicants respectfully submit that the present invention, as defined in Claims 1 through 8 distinguishes over the cited references, whether considered separately or in combination.

The present invention is directed to an apparatus and method for preventing oil from fouling the lower pressure side lines in a helium compressor in which oil is mixed with the helium under pressure in order to absorb and remove heat generated during the compression of the helium.

In such systems, the oil must be removed from the helium before the helium is used for cooling. Accordingly, as illustrated, for example, in Figure 1, it has been conventional in such compressor systems to provide an oil separator, such as element 17, and optionally in addition thereto, an oil adsorber 19 in the high pressure line. However, despite the presence of these elements, Applicants have observed that when such a compressor arrangement is used to supply a pulse tube refrigerator, some of the pulse tube refrigerator cold heads with rotary valve and flex lines were flooded with compressor oil over a period of time. This, despite the presence of the oil separator 17 and the oil adsorber 19. The present invention provides a method and apparatus for overcoming the problem of oil contamination of the type, which is heretofore been encountered with respect to such compressors when used with pulse tube refrigerators or other

systems which include a helium compressor with an internal bypass valve connected between the HP and LP ports.

Prior to the present invention, it was conventional wisdom that the problem of oil contamination in the flex tubes likely resulted from the ineffiency or ineffectiveness of the adsorber 19 connected to the high pressure (HP) port 16. However, as described in detail in the background portion of the present application, Applicants' experiments establish that such is not the case. Rather, Applicants' experiments have demonstrated that the problem of oil accumulation in the flex lines at the LP ports is the result of oil migration from the LP side of the compressor, through the non-return valve 13 and the low pressure (LP) port 18 into the LP line 65, as shown, for example, in Figure 1.

The present invention addresses and resolves this problem by providing "means for preventing oil carry-over from the compressor to the supplied equipment". More particularly, as recited in Claim 1, the invention includes means for preventing oil from leaving the low pressure port and traveling toward the supplied equipment. As recited in dependent Claims 2 through 5, the means for preventing oil carry-over may take any of a number of forms, including an oil trap located in the circuit between the low pressure port and the supplied equipment or an oil adsorber, a gas reservoir, or a combined reservoir and oil adsorber located at the same location. In addition, according to an embodiment

of the invention defined in Claim 6, a pressure actuated switch is located in the circuit between low pressure port and the supplied equipment, which switch is operable to stop operation of the compressor whenever the gas pressure at the low pressure port falls below a predetermined minimum value. Finally, according to an embodiment of the invention defined in Claim 7, a pressure relief valve, which is operable to return compressed helium from the high pressure port to the compressor in response to a predetermined pressure differential, is connected between the high pressure port and the compressor, "independently of the low pressure port". Claim 8 is a method claim which includes a step of "preventing oil from oil-laden compressed helium from traveling from the low pressure port to the supplied equipment.

Prior to the present invention, there was no recognition in the prior art that the problem of oil contamination or oil accumulation in the flex line at the low pressure port of the compressor resulted from migration of oil from the low pressure side of the compressor, through the non-return valve, and through the low pressure port. Accordingly, it is not surprising that none of the prior art documents teaches or suggests providing means for preventing such migration as a way to prevent oil accumulation in the flex line at the low pressure port.

The latter comment applies to all of the cited references. The Morse et al patent, for example, relates to a helium compressor which uses a mixture of gas

and oil to remove heat from the compressed helium, in the manner described previously. In Morse et al, storage tanks 40 are provided, which are controllably accessible to both high and low pressure lines. By storing gas from the high pressure lines, or venting stored gas into the low pressure line, the quantity of gas in the circuit may be controlled.

While Morse et al does provide an oil separator 30 to remove the bulk of the oil from the gas + oil mixture, and an oil adsorber 34 to remove the remaining oil (both of which are provided on the high pressure side of the pump 16 in the manner described previously in connection with Figure 1 herein), it does not teach or suggest the provision of "means for preventing oil from leaving the low pressure part towards the supplied equipment", as recited in Claims 1 and 8. In the latter regard, Applicants note that the Office Action refers to the accumulator 15 as a corresponding to an oil trap or an oil adsorber. However, nothing in the Morse et al patent suggests a basis for this conclusion. Rather, all that Morse et al says about the accumulator 15 is that it provides a buffer between the refrigerator and the pump (Column 3, lines 27-31). Thus, while the accumulator likely acts as a buffer simply to smooth variations in pressure during the operation cycles of the compressor 16 and the cryopump 17, nothing suggests that it acts as an oil trap or as means for preventing oil from leaving a low pressure port and traveling toward the supplied equipment.

Klusmier '736, on the other hand, discloses an arrangement for compressing a mixture of helium gas and oil, and for separating the oil from the compressed mixture by a series connection of an oil separator 38 and an oil adsorber. Collected oil is return to the compressor through the low pressure line 42. Much of the disclosure in Klusmier relates to the specific arrangement for cooling the compressor itself, which involves a circuit for pumped oil. However, like Morse et al, Klusmier does not teach or suggest the provision means for preventing oil from leaving the low pressure port and traveling towards the supplied equipment therefrom, as recited in Claims 1 and 8.

Finally, Kanai et al describes various safety valves for a CO_2 filled automotive air conditioning unit, and has been cited only in respect of Claim 6. The latter claim recites a pressure actuated switch in the circuit between the low pressure port and the supplied equipment to stop the compressor if the pressure on the low pressure line falls below a minimum value. In the equivalent position in the CO_2 filled automotive air conditioning circuit of Kanai et al, a rupture disk is provided, as described at Column 3, lines 26-38.

Applicants note, however, that the pressure switch of Claim 6 in the present application operates to turn off the compressor if the pressure in the low pressure line has become too low. In Kanai et al, on the contrary, the rupture disk operates to relieve an excessively high pressure in the low pressure line as

indicated at Column 3, lines 26-38. In addition, Applicants further submit that a rupture disk as such is not equivalent to a switch, and is incapable of turning off the compressor, as recited in Claim 6.

As is apparent from the foregoing brief descriptions, none of the cited prior art appears to address the problem of preventing oil from traveling along the low pressure line from the compressor, overcoming the non-return valve, and migrating further towards the supplied equipment, as described in the text of the present application. Accordingly, a combination of the references would not yield the present invention as claimed, and Applicants respectfully submit that Claims 1 through 8 distinguish over the cited references.

Furthermore, with regard in particular to the combination of Morse et al and Klusmier '736, as discussed in paragraph 13 of the Office Action, Applicants respectfully submit that a person skilled in the art would not be prompted by the disclosure in either document, or by any other consideration, to combine the two in the cited manner, and furthermore, that such combination would not yield the invention. That is, if the check valve of Klusmier '736 were placed in the coolant circuit of Morse et al, it would be placed in the corresponding position: between the low pressure side of the bypass valve 38 and the compressor pump 16. The claims of the present application, however, require the check valve to be positioned between the low pressure side of the bypass 38 and the supplied

equipment in the vicinity of label 12 in Figure 4 of Morse et al. Applicants respectfully submit that such a placement is not suggested by a combination of Morse et al and Klusmier '736.

Finally, Claim 7 requires a pressure relief valve that is connected between the high pressure port and the compressor, independently of the low pressure port. The Office Action states that the safety valve features of Figure 2 of Kanai et al satisfies this limitation. The valve elements 45 operate in response to an excessive pressure in the passage 38a to connect passages 38a and 38b. As explained at Column 6, lines 4-9, the passages 38a and 38b form bypass passage 13, which is shown in Figure 1 to be a bypass relief valve around a compressor. This proposition is confirmed by the valve as a whole being labeled 14 in Figure 2, corresponding to the relief valve 14 in Figure 1. There is no suggestion in Kanai et al, however, of connecting the valve 14 other than between the high pressure line and low pressure line. While the valve may operate to return compressed helium from the high pressure port back to the compressor as indicated in the Office Action, such operation is via the low pressure port as shown in Figure 1 of Kanai et al. It is therefore not performed "independently of the low pressure port", as recited in Claim 7. Accordingly, Applicants respectfully submit that Claim 7 distinguishes over the cited references for this additional reason as well.

In light of the foregoing remarks, this application should be in consideration for allowance, and early passage of this case to issue is respectfully requested. If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #038871.55852US).

Respectfully submitted,

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